EVIDENCES OF REVERSE FAULTS WITHIN SOUTH POLAR LAYERED DEPOSITS IN PROMETHEI LINGULA REGION (MARS). A POSSIBLE CLUE OF "ICE-CAP" MIGRATION?

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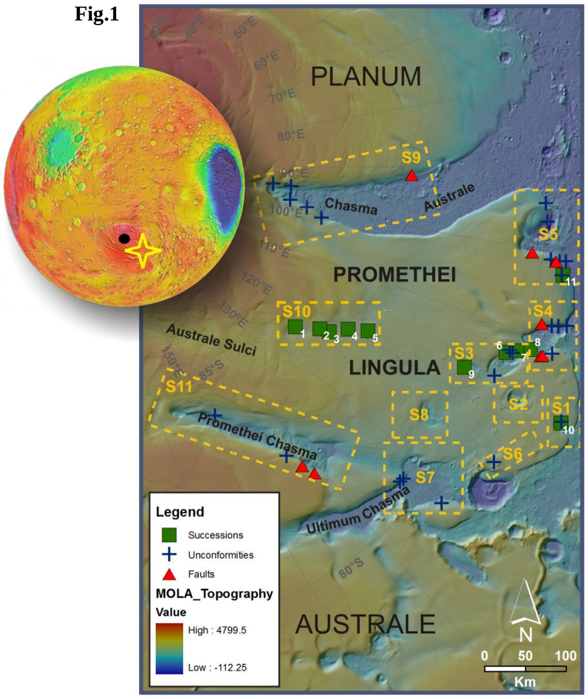
Introduction: Brittle and ductile deformational features have been indentified within South Polar Layered Deposits (SPLD) by several authors [1,2,3] (normal and reverse faults, thrusts, folds), but in particular only on Ultimi Lobe region [4,5,6].

In the present work we focus on Promethei Lingula region (PL, Planum Australe), between 80°-85° S Lat and 90°-150° E Long (Fig.1, Sites S1÷S11, Sections 1÷11). For visual observations we used HRSC plus several hi-res MOC NA, CTX and HiRISE images. The elevations of surface are calculated from MOLA 512 pix/deg grid topography.

Fig.1



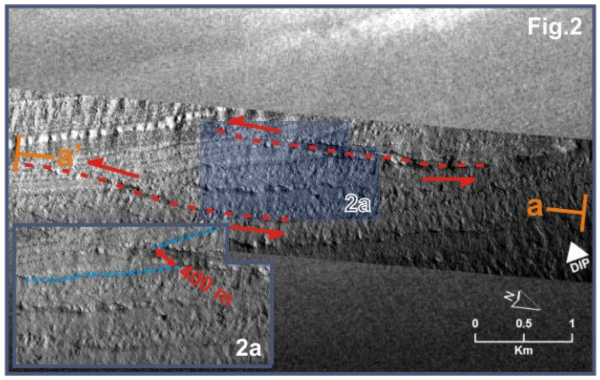
Observations: Several deformational structures are exposed on some troughs walls and on the marginal scarps of PL (red triangles in Fig.1). In particular we found evidences of brittle and brittle-ductile structures on seven zones so far. Here we describe three significant examples. The first one is located on a trough's scarp (Fig.1, Site S4, 79.44S Lat, 112.25E Long) and it's characterized by two main sub-parallel low angle brittle planes (Fig.2). These faults, located in the upper part of the section (Fig.2b), displace with a reverse movement (thrust faults) a layers package between 2200÷2300 m. A possible left-lateral strike slip component is not to be excluded. The estimated total offset is around 400 m (Fig.2a). Faults planes appear to be filled with dark cataclastic-like material. The second main deformational zone is located on the lingula margin (Fig.1, Site 5, 80.22S Lat 100.41E Long) and it's characterized by spectacular wide ductile-fragile structures (Fig.3). The main sub-parallel faults planes displace almost entirely the layers sequence, located between 1350÷1925 m (Fig.3b). The maximum observed offset is of about 2 Km (Fig.3a). Several kinematic indicators as drag folds, kink folds and shear "Z" shaped folds indicate a predominantly reverse component plus a possible right-lateral movement (reverse and/or transpressive faults). The last one is located at 82.10 S Lat 141.93 E Long on the Promethei Chasma margin (Fig.1, Site 11). Here ductile-fragile deformations show a low angle reverse displacement of layers package located between 2430÷2500 m (Fig.4-4a). The extension of the main fault plane, related to a "Z" shaped fold, is of about 6 Km. The maximum offset is around several hundred meters.

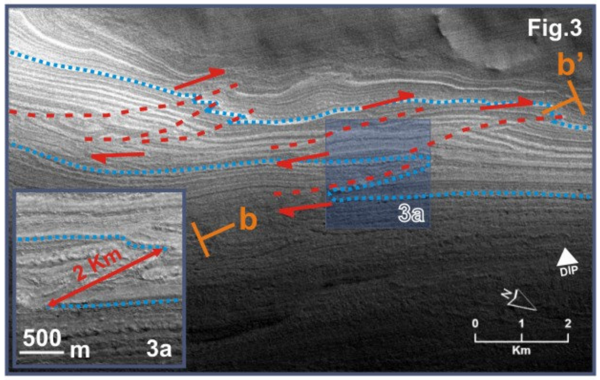
Discussion: All observed deformational systems (regionally distributed) seem not active at present. They show a main reverse kinematic, traced by several low angle (thrusts) and medium angle (reverse) faults planes. Some of these features appear to have a secondary right lateral kinematic component (transpressive faults). The peculiar anomaly is the complete absence of extensional structures (normal faults and/or half graben systems) in the vicinity of marginal scarps. As we could expected here, layers should have a relaxation outwards. But unlike this, we observed only strains linked to compressional stresses.

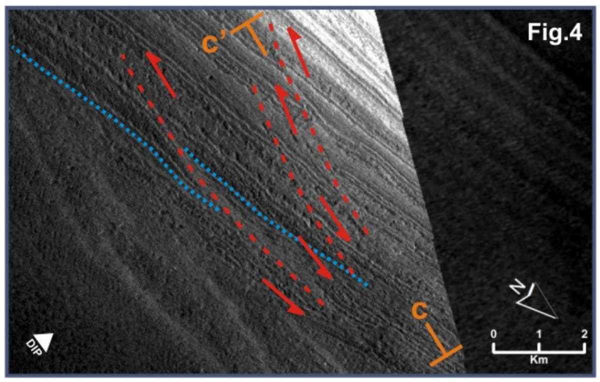
Therefore currently we can only speculate about the causes. Because of the presence of deformations, it is certain that at some point the PLD cap moved (only locally?). Two possibly related mechanisms can be invoked: 1) The convergence of differential stresses caused by the internal moving of ice deposits through ice flow (morover proved by the viscous relaxation of craters on SPLD [7]). For example, the internal ice convergence could be generate in coincidence of concave shaped scarps (Fig.5a). 2) The interaction of the PLD "ice-cap" with bedrock dued to its possible migration from the centre towards the outside through basal sliding. For example, the downstream presence of high topographic morfologies can offers resistance to the ice movement, creating compressional/transpressive stresses within layered deposits (Fig.5b). Both factors would had caused the layers detachment along weaker levels and the partial overlapping of the successions throughs reverse faults (Fig.5c).

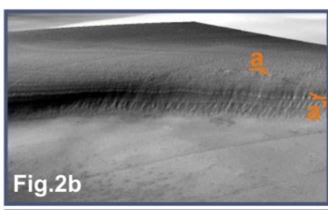
Conclusions: Our preliminary analyses identified reverse/transpressive faults in PL region, useful to understand the past kinematics of ice cap. Their movements seems to be consistent with an ice cap migration (local or regional) towards its margins (ice flow), perhaps influenced by interaction with bedrock topography (basal sliding). We plan to model the observed strain, as it could be useful to better understand the mechanisms and the causes of its possible past migration, perhaps linked to (ancient?) basal melting (i.e. presence of liquid water under the cap as some geomorphological structures - eskers [8,9,10,11] - and fisical/geochemical studies [12,13] seems to suggest.

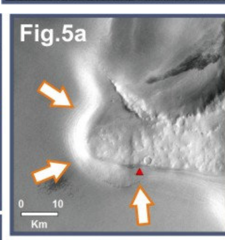
References: [1] K.E. Herkenhoff et al. (2003) *Third Mars Polar Science Conf.*, Abstract #803. [2] K.E. Herkenhoff et al. (2008) *LPSC XXXIX*, Abstract #2361. [3] J.S. Kargel (2001), *Eos Trans. AGU*, *82*(47), F724. [4] S.M. Milkovich and J.J. Plaut (2008) *JGR*, *113*, E06007, 10.1029/2007JE002987. [5] E.J. Kolb and L. Tanaka (2006) *Mars*, *2*, 10.1555/mars.2006.0001. [6] B.M. Murray (2001) *Icarus*, *154*, 80-97, 10.1006/icar.2001.6657. [7] A.V. Pathare et al. (2004) *Icarus*, *174*, 396-418, 10.1016/j.icarus.2004.10.031. [8] J.S. Kargel (1993) *LPSC XXIV*, Abstract #753. [9] J.W. Head (2000) *LPSC XXXI*, Abstract #1119. [10] J.W. Head (2001) *JGR*, *106*, 0148-0227/01/2000je001315. [11] J.W. Head (2003), *EGS - AGU - EUG Joint Assembly*, Abstract #2725. [12] J.J. Plaut et al. (2007) *Science*, 10.1126/science.1139672. [13] D.A. Fisher et al. (2009) *LPSC XL*, Abstract #2281.

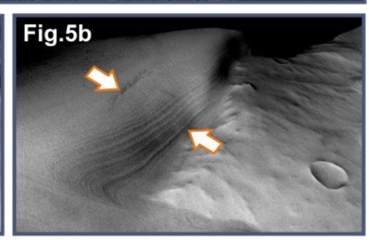


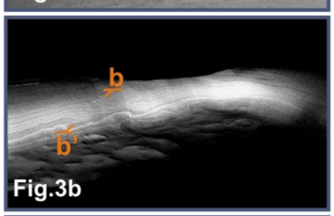


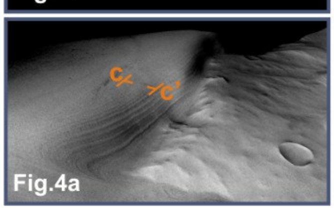












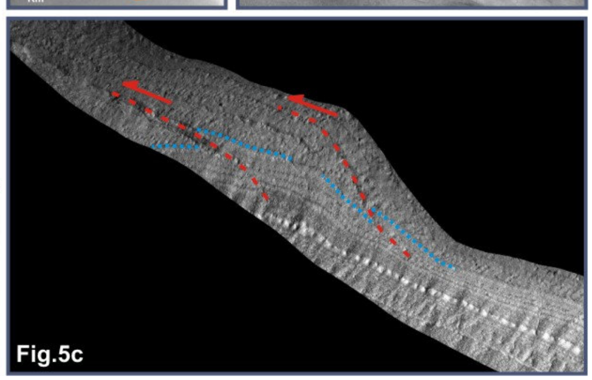


Fig.2÷2a Thrust faults. Site 4 – *MOC R1103900 (1.5 m/pix).*
(2b) Location section in Fig.2.
Fig.3 Ductile – fragile deformational structures. Site 6 – *CTX P09_004708_0998 (5.0 m/pix).*
(3a) HiRISE PSP_4708_1000 (0.25 m/pix).
(2b) Location section in Fig.3.
Fig.4 Reverse faults. Site 11 – *Themis Vis V25643011RDR (17 m/pix).*
(4a) Location section in Fig.4.
Fig.5a÷5c Hypothetical model of PLD's stress/strain mechanisms.
(5a) HRSC H4660 (21.2 m/pix).
(5b-c) MOLA DEMs (v.e. 5x).